USAWC STRATEGY RESEARCH PROJECT

THE UNMANNED AERIAL VEHICLE'S IDENTITY CRISIS

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
03 MAY 2004		**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
The Unmanned Aerial Vehicle's Identity Crisis	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
Dennis Larm	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
U.S. Army War College,Carlisle Barracks,Carlisle,PA,17013-5050	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
See attached file.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**		**34**	

ABSTRACT

AUTHOR: Dennis Larm

TITLE: The Unmanned Aerial Vehicle's Identity Crisis

FORMAT: Strategy Research Project

DATE: 19 March 2004 PAGES: 26 CLASSIFICATION: Unclassified

Strategic leaders of the information age face a future of ambiguous threats and challenges, as well as potential technological advancements, never before envisioned just a few years ago. Many lessons of the past may no longer apply to vastly complex conditions of the future. However, past experiences provide the foundation from which leaders can best align and posture themselves to take rational leaps of visionary faith. Hopefully, such instrumental leaps will have ideal direction and enough momentum to land on stable approaches to best traverse grounds of future threats and challenges.

The unmanned aerial vehicle's (UAV's) sense of identity is ambiguous due to past experiences. It is still in an infancy stage when compared to the advanced evolutionary lines and numerous roles and missions of manned aircraft. This paper examines the history and background of the UAV to identify and document principal reasons for its immaturity.

Strategic visionaries must have open minds to explore new ways of developing, transforming, and employing assets. They must search for new approaches in order to best support effective application of all instruments of power. The United States of America can no longer simply respond to the changing environment with belated modifications to existing systems and strategies. In order to remain the world's greatest superpower, US strategic leaders must be openly aggressive in the pursuit of innovation.

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ACKNOWLEDGEMENTS

I sincerely thank all colleagues, faculty, staff, and support personnel of the United States Army War College (USAWC) and Carlisle Barracks for providing every possible manner of intellectual, physical, and spiritual support contributing to a superb year of professional and personal development. I specifically wish to single out and convey great appreciation to my faculty advisor, Colonel Chris Paparone, for being a true academic warrior role model and for his sincere and meaningful advice, guidance, and mentorship. Finally, I acknowledge the blessings of being a member of Seminar 16 "Brewmasters," the best seminar of USAWC Class of 2004—*Best wishes for good times and joy-filled memories!*

THE UNMANNED AERIAL VEHICLE'S IDENTITY CRISIS

> We have just won a war with a lot of heroes flying around in planes. The next war may be fought with airplanes with no men in them at all. It certainly will be fought with planes so far superior to those we have now that there will be no basis for comparison. Take everything you've learned about aviation in war and throw it out of the window and let's go to work on tomorrow's aviation. It will be different from anything the world has ever seen.
>
> —Henry H. "Hap" Arnold

General Arnold's vision of fighter aircraft "with no men in them at all," has yet to fully materialize despite the fact that he spoke those words sixty years ago. The vision of a combat unmanned aerial vehicle (UAV), however, did enter an infancy stage of reality during the Global War on Terror as UAV operators used weaponized Predators to strike targets in Afghanistan, Yemen, and Iraq. The Predator UAV was originally designed as a reconnaissance platform, not a combat attack system. If the infamous terrorist attacks of September 11, 2001 upon the World Trade Center towers and the Pentagon never took place, it is unlikely that Hellfire-equipped Predators would exist today. The reason is not for lack of vision—decades of documentation detail a multitude of potential UAV roles and missions for the future. The reason is that the UAV suffers an identity crisis. It has been trapped in an image of primarily being a reconnaissance platform and it has never had an advocate in a position to champion its advancement and development to other roles and missions.

In his book, *The Masks of War*, author Carl H. Builder details the "entrenched institutions and distinct 'personalities' of the three armed services." Builder asserts the Army's sense of identity: "was skewed by its experiences during World War II" and "has been frozen there by the interests of its powerful branch structure."[1] The UAV's identity crisis is similar in nature, but its image paralysis may be even more difficult to overcome. Its sense of identity was likewise skewed by past experiences and frozen by the interests of the power structure. However, unlike the Army's situation, the UAV is not trapped against moving toward change because internal fiefdoms want to maintain power within the status quo, but because the UAV has no fiefdom to affect change.

INTRODUCTION TO UAV HISTORY

One major obstacle to the wider development of UAVs is that eventual users of any new technology are historically reluctant to embrace it. This is particularly true when strategic

military leaders and operators deem existing systems adequate and there appears little reason to replace them. Social theorists and scientists call this tendency "structural inertia," whereby firms and organizations (in the business world) must experience a survival-threatening crisis before meaningful change can be catalyzed.

After the attack on Pearl Harbor, the US Navy designed and successfully tested attack remotely piloted vehicles. Despite these successful experiments, Admiral Jack Towers, head of US Naval Aviation, "was opposed to any program of production until the new device had shown itself to be *superior* in combat to the conventional manned aircraft of the fleet" (emphasis added).[2] When the war in the Pacific turned in favor of the United States, Admiral Chester W. Nimitz, commander in chief of the US Pacific Fleet, "was reluctant to accept a new and untried weapon (attack remotely piloted vehicles) when the combat resources already available to him were performing so well."[3] Retired Major General I. B. Holley (author and lecturer on military subjects) points out the paradox that military failures are often more valuable than successes in understanding lessons of war. "Success stimulate blind pride and complacent self-confidence," he noted, "which invite failure in future battles."[4]

In the early 1900s, military historian J. F. C. Fuller recognized that replacing cavalry with armored forces would encounter institutional difficulties. "To establish a new invention," he wrote, "is like establishing a new religion--it usually demands the conversion or destruction of an entire priesthood."[5] This sentiment remains applicable among the airpower "priesthood" of today. In an atmosphere of competition for funds with manned aircraft, it is logical that there currently exists a reluctance to embrace UAVs. In turn, this institutional bias resulted in a failure to fully recognize their latent capabilities.

Nearly all new inventions which provided some form of "high ground" advantage in war (i.e., balloon, dirigible, and airplane) were first used as reconnaissance platforms. Military leaders eventually recognized their true potential and would effectively use them in other new and innovative airpower roles. The balloon had interesting applications in World War I. Because they were such tempting targets for enemy aircraft, balloon observers resorted to carrying weapons. In April 1917, "a French balloonist named Peletier was credited with downing an attacking 'Albatross' with a shot from his Winchester."[6] Allied units also conceived and deployed lethal balloon basket decoys, occupied with a dummy observer and filled with several hundred pounds of explosives. One British unit reported of dramatically destroying a German attack with this type of "aerial mine," which it had electrically detonated from the ground.[7]

Institutional bias and initial lack of vision for more diverse applications appear to be

common trends for new forms of airpower. Even manned aircraft had initial difficulties gaining military acceptance and recognition as potential weapons of destruction. Shortly after the birth of powered flight, General Ferdinand Foch reflected the classic disdain that cavalrymen had for the airplane. He dismissed the Wright brothers' invention as good for sport, but of no value for the Army.[8]

Airpower in general underwent major growing pains as theorists attempted to determine its role in warfare. The airplane's first use in war was as a flying platform for observation and artillery spotting. In the United States, the airplane was first adopted by the Army Signal Corps, who used it for reconnaissance. As airpower's potential became more apparent, aircraft acceptance grew. Militaries eventually applied them in more diverse combat roles such as close air support and bombing.

Today, all strategic leaders understand and appreciate airpower. This understanding, however, is limited mainly to manned aircraft. US military services primarily use UAVs for reconnaissance. The Department of Defense only recently used armed Predators for the Global War on Terror, and only did so after the UAV attack concept was proven by another agency. Within weeks after the September 11, 2001 terrorist attacks, the Central Intelligence Agency (CIA) was the first to utilize Hellfire-armed Predators in Afghanistan. CIA Predator operators are credited with hunting down and killing dozens of al-Qaida and Taliban targets in Afghanistan and Yemen. Most notable among those killed were Mohammed Atef, the al-Qaida terror network's military chief, and Qaed Senyan al-Harethi, a key suspect in the October 2000 attack on the USS Cole. Realizing the value of this attack asset, the US Air Force subsequently developed and used armed MQ-1 Predators[9] for missions in support of Operation ENDURING FREEDOM in Afghanistan, and Operations SOUTHERN WATCH and IRAQI FREEDOM in Iraq. Despite these recent mission accomplishments, the UAV's potential to perform in more diverse roles has barely yet to be fully explored and exploited.

FIRST UAV CONTACT

The Wright brothers were recently honored worldwide for making aviation history 100 years ago. By comparison, the first developers of unmanned aircraft (e.g., Rene Lorin of France, Professor A. M. Low of Great Britain, Lawrence Sperry and Charles F. Kettering of the United States) are virtually unknown by even those in the airpower profession.[10] All these early pioneers experimented with military applications, and their first concepts of UAVs were as expendable "flying bombs." Still, it is remarkable how quickly after the "dawn of aviation" at Kitty Hawk in 1903 that unmanned as well as manned airpower evolved for use in war.

WORLD WAR I

Prior to World War I--and even before the required technology fully existed--Lorin, a French artillery officer, first proposed the concept of flying bombs to attack distant targets.[11] In Germany, experiments on guided aerial vehicles began in 1915 and included launches from airships. In the United Kingdom, experiments beginning in 1917 produced unmanned aircraft with newly designed, expendable engines.[12]

British Professor Low led the research program to design and develop a true remotely piloted vehicle. Some historians bestowed upon him the title, "Father of the Remotely Piloted Vehicle," for being a pioneer in this field.[13] During World War I, the British suffered heavy pilot losses against German Fokker monoplanes over the western front. In response to this situation, the Royal Flying Corps (RFC) assigned Low to a secret program titled, "RFC Experimental Works." As a newly commissioned second lieutenant, Low attempted to develop a UAV "that could serve as both an interceptor and ground-attack weapon."[14] Numerous problems--many attributed to using existing aircraft components to save on time and money--restricted development beyond the prototype.

The Royal Aircraft Factory, attempting to build upon lessons learned from Low's early prototype, produced an unmanned Sopwith biplane which could carry a 50-pound warhead in its nose. Its performance during an important test was disastrous: "During a test flight...for a gathering of important Allied dignitaries, the AT (aerial target) went astray and dove upon the guests, who scattered in every direction."[15] This unfortunate incident halted further development and destroyed any British hopes of deploying UAVs during World War I.

During the same time period in the United States, the Navy and Army began separate research and development programs which, respectively, developed the Sperry-Curtiss "Flying Bomb" and the Kettering "Bug." Upon reaching a preset range, the wings of these "aerial torpedoes" released and their fuselages fell as gravity bombs. Sperry, son of Dr. Elmer A. Sperry (who developed the gyro-stabilization system, making autopilot possible in 1915), led the Navy program.[16] Sperry's Flying Bomb was the first UAV to achieve autonomous flight. Kettering, who used Orville Wright as his aeronautical consultant, led the Army program. Kettering's Bug was capable of carrying an explosive payload of 180 pounds and could fly distances up to 40 miles at 55 miles per hour.[17] After World War I ended, defense budget cuts eventually terminated these aerial torpedo programs.

TIMEFRAME BETWEEN WORLD WARS

Better remote control of an aircraft required advanced radio technology, which came in the 1920s. The US Army Air Corps performed research into remote control by radio on Curtiss Robin and Stimson Junior aircraft. In 1928, a Curtiss Robin monoplane became the first remotely controlled, bomb-carrying aircraft.[18] Lack of funding caused the military to cancel the program within four years. It would be an additional six years before the Army Air Corps would pick up on UAV research again.

The British also conducted extensive experiments with radio control and produced unmanned aircraft with speeds much greater than manned aircraft of the era.[19] Follow-on British efforts focused on developing remotely piloted aerial targets. In 1933, a radio-controlled floatplane revealed the vulnerability of ships to attack from the air. Simulating an air attack on the British Royal Navy, the unmanned aircraft survived more than two hours of heavy naval gunfire before being safely recovered, undamaged. While General Mitchell first demonstrated ship vulnerability (by test sinking several warships with aerial bombs), the British took the test to another level. In one flight, "not only had the inadequacy of naval anti-aircraft weapons been demonstrated, but so had the undeniable feasibility of remotely piloted aircraft."[20] Following this demonstration, the British developed an expendable, all-wooden version of the aerial target called the Queen Bee. A total of 420 were built for Royal Navy and Army anti-aircraft gunners. According to Air Chief Marshal Sir Michael Armitage (Royal Air Force [RAF] writer and lecturer on airpower and UAVs), "The fact that nearly all of them rendered very valuable service before being destroyed says more about the state of contemporary anti-aircraft defenses than it does about the resilience of the Queen Bee aircraft."[21]

In 1935, Reginald Denny (American movie star and model airplane enthusiast) founded the Radioplane Company, which produced a radio-controlled, miniature monoplane.[22] The Army Air Corps and Navy purchased nearly 1,000 Radioplane UAVs to provide their anti-aircraft gunners with realistic flying targets.[23] The following year, the Navy modified full-sized airplanes to serve as aerial targets. Upon learning of the Navy's efforts, General Hap Arnold desired to initiate a similar target program in the Army Air Corps. In 1939, he requested and received a suite of identical equipment for Air Corps research.[24]

During the years between the world wars, militaries of different nations explored various areas of technology having potential application to UAVs. The most well-known product, however, used a simple, inexpensive engine first developed and patented in France in 1907.[25] In 1939, German scientists and engineers used its design to create prototypes of the Fiesler 103, now more widely known as the V-1 (Vergeltungswaffe Eins) Buzz Bomb.

WORLD WAR II

With a launch of 10 weapons on 13 June 1944, the V-1 became the first operational cruise missile. It was also the first jet-propelled weapon and the first strategic terror weapon used in war. The V-1 had three important advantages: it was relatively cheap to build, it did not place any undue demands on Germany's limited strategic resource materials, and it avoided the loss of scarce and valuable Luftwaffe crews.[26]

From June 1944 through March 1945, the Luftwaffe attacked London by launching 8,892 V-1s from ground sites and approximately another 1,600 from aircraft. Allied fighters and anti-aircraft guns destroyed most of these before they reached their intended targets. However, the 2,419 V-1s which did reach the London region killed 6,148 and seriously injured 17,981.[27] Germany launched an additional 12,000 V-1s towards Antwerp, of which 2,448 struck the vital Belgium port city. While the V-1s caused some considerable physical damage, their use as retaliatory weapons had much wider ramifications.

By August 1944, after only three months into the V-1 campaign, an estimated one and one-half million Londoners had fled the capital. Coupled with time spent in shelters, absenteeism, and an overall strain on civilian morale, productivity in the city's factories suffered. The Allies diverted extensive airpower resources away from other missions to bomb V-1 launch sites and to shoot down V-1s in flight. These operations were costly—"nearly 450 aircraft were lost and 2,900 valuable aircrew lives were sacrificed."[28]

In a separate program, the German army also produced its own retaliatory weapon--the A-4--which was later called the V-2. The V-2 was essentially a ballistic missile. Although less vulnerable and more physically destructive, the V-2 was a significant burden on Germany's war-making capability. It was expensive, it used extremely complex technology, it required scarce materials, and it greatly overstressed Germany's electric and component industries. Comparing the V-1 and V-2 in terms of cost (in German marks) and labor: the V-2 cost 10,000 marks compared to 1,500 for the V-1, and it required 13,000 hours of slave labor compared to 280 for the V-1.[29] In terms of total destructive potential, because Germany produced and launched significantly fewer V-2s (3,200 compared to 22,400 V-1s), the V-1 delivered many times more explosive loads.[30] Ironically, because there was no apparent defense against the V-2, the Allies diverted fewer resources to counter it.

In addition to the V-1 cruise missile and V-2 ballistic missile, Germany employed other UAV weapon systems during World War II. Despite lessons learned in 1933 from the British test of the unmanned floatplane against naval defenses, the Royal Navy and the US Navy both

suffered significant losses from German glide bombs. The two most prominent glide bomb systems were the Fritz X remotely guided bomb and the HS 293 remotely piloted jet-propelled aircraft.[31] Luftwaffe airborne controllers released these radio-controlled weapons and directed them by line of sight onto surface targets. From September 1943 through August 1944, German glide bombs sunk or significantly damaged the following naval vessels: Italian flagship *Roma*, Italian ship *Italia*, USS flagship *Savannah*, HMS *Uganda*, hospital ship *Newfoundland*, HMS *Warspite*, HMS *Janus*, HMS *Jervis*, hospital ship *St. David*, sister ship *Leinster*, HMS *Egret*, and others (not identified by name).[32]

A number of German UAV experimental systems also demonstrated potential, but none were far enough advanced to become operational before World War II ended.[33] German remotely piloted vehicle research into acoustic, television, infrared (IR), radar, and wire guidance systems would eventually be used to create remotely controlled and autonomous weapon systems in existence today. The United States and the Soviet Union were the primary beneficiaries of this work, as many prominent German scientists eventually ended up in one of these two countries.[34]

Allied UAV research and development (R&D) efforts conducted during World War II were not as advanced as German accomplishments. Some are noteworthy, however, for their innovative concepts. In February 1941 the US Navy pursued research into UAV television transmission. This led to the development of an assault drone, which was remotely controlled with the aid of video guidance. The Navy demonstrated the first successful US kamikaze-type mission by flying such an aircraft into a target. Despite this research, the United States limited operational employment of UAVs during World War II to a few glide bomb missions and the use of converted war-weary or time-expired B-17s and B-24s.

Project Aphrodite was the US effort to convert war-weary manned aircraft into unmanned flying bombs.[35] Ironically, the United States initiated the special project to develop a means to attack hardened German V-weapon launch sites which were practically invulnerable to normal bombing attacks. By the time the US Army Air Forces (USAAF) could launch its first war-weary aircraft in July 1944, Allied aircraft and airmen losses from attempts to knock out V-1 sites were considerable.[36]

Stripped of all unnecessary equipment, USAAF personnel reconfigured B-17 bombers with radio control systems and loaded them with 20,000 pounds of explosives. One pilot and technician launched the aircraft towards enemy target areas and bailed out before crossing the English coastline. An escort B-17 remotely controlled the flying bomb towards its designated target. No war-weary aircraft ever scored a direct hit on its intended target, and the Aphrodite

project was plagued with tragic as well as somewhat comical results.

On the side of tragedy, launch crews from the first 10 war-weary B-17 missions suffered the death of one pilot in a crash and the injury of seven others during bailout. US Navy participation in Project Aphrodite involved radio-controlled PB4Y (B-24) Liberators. Lt Joseph P. Kennedy, brother of future president John F. Kennedy, was killed on the first naval Aphrodite mission in August 1944; his B-24 prematurely exploded before he could bail out over England. According to military historian Conrad C. Crane, "fears of his father's reaction caused much consternation at many military headquarters," and the Navy subsequently suspended the project.[37]

Three war-weary missions provided a humorous side to Project Aphrodite. In the first case, "one enterprising controller, finding that he could not dive his robot aircraft, flew it around an unsuspecting German flak battery until a direct hit destroyed both the war-weary and the battery." In the second event, one war-weary went out of control and eventually crashed and exploded in Sweden; "Swedish military authorities just sent a polite note with regrets that they could find no trace of any crewman." The last incident also involved a war-weary that went out of control and disappeared. In this case the escort B-17 finally discovered the unmanned aircraft circling the English town of Ipswitch, whereupon "a frantic controller barely managed to dump it into the North Sea."[38]

In spite of a series of later improvements (adding a television monitor, altimeter readout, and remote control throttles), war-weary aircraft were vulnerable to German defenses and thus proved highly ineffective. In light of mission failures, Lt Gen James H. "Jimmy" Doolittle delivered sharp criticism upon the Aphrodite project: "It seems to me that this whole project is put together with bailing wire, chicken guts, and ignorance."[39]

Despite the lack of operational UAV successes in World War II, the United States conducted valuable research and increased its knowledge base in this form of airpower. The military took great strides in guided vertical bomb research in radio, radar, television, and infrared controls.[40] In October 1945, the US Navy released drawings of unmanned jet aircraft concepts. Designers claimed that speeds up to 300 miles per hour and 4-G dives would be achievable. The Navy described the projects as "heralds of a supersonic age where only the mind of man can match the speed of the deadly creatures his genius has conceived."[41] Concepts such as these, however, came too late for operational employment during the war and they were not further pursued.

KOREAN WAR

The Korean War did little to prompt advances in UAV technologies. Some World War II-era guided bombs were used, but many were in poor condition due to sever deterioration from a long period in storage. Three specially modified B-29s employed approximately 30 glide bombs, and they accounted for destroying six bridges and damaging one.[42] While their poor accuracy was not a major factor against World War II-era targets (i.e., German cities and industries), they were essentially useless against most North Korean targets. Also during the Korean War, various manned aircraft were converted into flying bombs, which were remotely guided into heavily defended communist targets.

In 1951, the United States produced its first jet-engine target drone called the Firebee. Virtually every US air defense weapon has been tested against Firebee droned developed by Teledyne Ryan Aeronautical.[43] "The long term significance of Teledyne Ryan family of unmanned aircraft was their adaptability, and in particular their operational potential."[44] It is noteworthy that Teledyne Ryan, founded by Claude Ryan, is the company that built both Charles Lindbergh's *Spirit of St. Louis* in 1927 and the Firebee jet-propelled remotely piloted vehicle (RPV) in 1951.[45]

POWERS SHOOTDOWN EVENT

The watershed event in US UAV development history--the event which directed UAV R&D towards its current state--came on 1 May 1960.[46] It was the shootdown over the Soviet Union of the U-2 reconnaissance aircraft piloted by Francis Gary Powers.[47] United States' strategic leaders subsequently focused on developing unmanned intelligence collection platforms, and this directed efforts away from development of attack remotely piloted vehicles. The United States quickly established the Red Wagon project to study drone reconnaissance potential. In July 1960, the United States awarded Ryan Aeronautical Company an initial $200,000 contract for a remotely piloted vehicle demonstration. The result was an aircraft which successfully demonstrated stealth characteristics and the ability to carry photographic reconnaissance cameras. However, competing against satellite systems and the emerging manned SR-71 project, continued support for UAVs slipped. According to Air Chief Marshal Armitage, "This promising start was however followed by disappointment for the designers when shortage of Pentagon funds caused all the available budgetary resources available for new reconnaissance assets to be devoted to the emerging SR-71 Mach-3 reconnaissance aircraft."[48]

After nearly two years of being held in abeyance, approval was given in February 1962 to proceed again with the UAV reconnaissance program. On 27 October of that year, another

U-2 (this one piloted by Rudolph Anderson Jr.) was shot down over Cuba during the missile crisis. Under the Big Safari acquisition program, US efforts were accelerated to develop an unmanned aerial reconnaissance platform. Of the many variations developed, one concept advanced UAVs into a unique role. A remotely piloted vehicle was fitted to carry a wave tube, which gave it the radar characteristics of a much larger aircraft. This decoy system was intended to stimulate the SA-2 radars in Cuba in order to collect transmission data on them.[49]

SOUTHEAST ASIA CONFLICT

The first UAV photographic reconnaissance flight came in 1963. The Gulf of Tonkin incident on 4 August 1964 led to operational involvement of reconnaissance UAVs over China and Vietnam. The first combat loss of a UAV came when China downed one in November 1964. By April 1965 four more were lost to Chinese air defenses, and China held a news conference to display wreckage of downed US pilotless aircraft to the public. The significance of this event is its lack of impact on US as well as world opinion. While it showed the vulnerability of such aircraft, "the most significant feature of the American losses," according to Armitage, "was that clearly identifiable US manufactured aircraft did not receive the same public attention as would have been the case with captured American crew members from, say, U-2 reconnaissance aircraft."[50]

In April 1969 another US manned reconnaissance aircraft was lost. In this incident a Super Constellation EC-121 (an electronic countermeasures aircraft) was shot down as it deliberately attempted to stimulate and collect North Korean radar transmissions. Although nearly 200 such flights had been previously conducted, on this occasion North Korea not only activated its surface to air missile (SAM) radars but also launched two MiG interceptors. One of the MiGs intercepted and shot down the Super Constellation aircraft, killing all 31 crew members. The incident prompted President Richard M. Nixon to end the program of conducting electronic warfare missions against North Korea with manned assets. More importantly, however, according to Armitage: "This incident led directly to a proposal that the recently developed 147T (Teledyne Ryan UAV Model) should be used to carry a relay system by which electronic emissions could be collected and re-transmitted over an FM radio link to a ground station, thus obviating the risk of further losses to conventional aircraft and their operators."[51]

From 1964 to 1973, Strategic Air Command (SAC) operated 148 UAVs for Buffalo Hunter operations in Southeast Asia. Conducting nearly 3,500 sorties with less than a four percent loss rate, SAC completed high-risk missions in photographic, communications, and electronics reconnaissance, as well as leaflet and chaff dropping.[52] These operations resulted

in many operational lessons, prompting new innovations in UAV development. Improved command guidance, intelligence gathering, active defense, and flight control systems were the result of Buffalo Hunter operations.[53]

The survival rates of US remotely-piloted vehicles in Southeast Asia were remarkable given their missions were flown in the full range of weather and combat conditions. One specially modified drone was reported to have drawn 10 or 11 SAMs before being shot down.[54] The top performing drone flew an incredible 68 sorties, averaging twelve targets per mission.[55] In the latter part of the war, survival rates of UAVs exceeded 90 percent. While difficult to make a direct comparison, there is a definite contrast with manned aircraft statistics: "In that same war America lost more than 2,500 manned aircraft, about 5,000 of her airmen were killed, and nearly 90 percent of *all* US servicemen taken prisoner were pilots and crewmen.[56]

Despite the successful US missions conducted over Southeast Asia, there were difficulties associated with UAVs. Initially, novice operators and maintenance crews were only able to generate three to four sorties per airframe. By the end of the war, they managed to increase this number to 25. During this learning experience, any loss still caused repercussions. This was because military leaders treated it in the same manner as the loss of manned aircraft. In 1979, US Air Force Col William E. Krebs authored a paper titled, "Did We Err in the Development of RPVs?" One of his findings was that during the Vietnam War, "an RPV loss was treated like an aircraft loss—fleets were grounded, boards formed, data generated, commanders fired, and worst of all, prejudice against RPVs vis-à-vis manned aircraft developed."[57]

The time frame of US involvement in Southeast Asia was a period of extensive UAV research and testing. The evolutionary program for Teledyne Ryan's Firebee consisted of 26 configurations, 903 airframes, and 1,100 major modifications.[58] UAV test demonstrations extended well beyond reconnaissance into attack roles; however, it was the Navy, not the Air Force, leading this effort. According to *Jane's Remotely Piloted Vehicles*: "The US Navy has even evaluated RPV interceptors in simulated air combat against a McDonnell Douglas F-4 Phantom II flown by a highly experienced aircrew. The results were thought-provoking. All the Sparrow and Sidewinder missiles launched from the Phantom missed the RPV, but the latter maneuvered itself several times into positions from which it could have brought down the Phantom had it been armed."[59]

ISRAELI EXPERIENCE

At this same time that the United States was attempting to understand and appreciate

unmanned aircraft, the Israeli Defense Force effectively used UAVs over battlefields in the October 1973 Yom Kippur War and again in the 1982 Bekaa Valley air battle. The Israelis innovatively employed unmanned aircraft to "fingerprint" SAM radars, simulate full-size decoy attack aircraft, perform electronic countermeasures, and conduct real-time intelligence gathering.[60] Most noteworthy was their effective use as decoys. By sending in UAVs to spearhead an attack, virtually all enemy SAMs were expended at once. This revealed SAM locations, and Israeli suppression of enemy air defenses sorties were thus able to follow and knock out missile defenses while the enemy was reloading. It was reported that one UAV safely returned for recovery after surviving attacks by 32 SAMs.

FROM SAC TO TAC

In light of tests and operational applications in Southeast Asia, lack of advocacy and proper oversight restrained any motivation in the United States to look beyond reconnaissance roles. The Air Force did develop ballistic missiles and precision-guided missions, but this was not because research revealed these systems should be pursued while others discounted. In fact, the Air Force conducted a study in 1974 on missions for UAVs and found itself guilty of ambivalence: "The study found that the concept of air combat drone/RPV systems was formulated in 1970, but little had been done subsequently to either promote the development of these systems or to dismiss them as viable systems for Air Force consideration."[61] There even rose an accusation that the Air Force suppressed the study because it revealed UAVs could perform several missions flown by pilots more cheaply and more effectively. [62]

In 1976 the USAF restructured command responsibilities, and SAC passed control of UAVs to Tactical Air Command (TAC). Because of promising results from industry and Navy tests--as well as successful RPV operations over China, North Vietnam, and other Far East areas--a whole range of additional roles was envisioned. Transference of ownership was another watershed event which would adversely affect the timing and extent of all future UAV development. Under TAC, Air Force support for unmanned systems deteriorated due to the increasing competition for funds against manned aircraft.

In 1978 Sen. John Tower (R-Tex.) emphasized lack of Air Force support for UAVs in the following statement: "I suggest that a full-blown strike RPV program that would really impact on the numerical differences will not be easy for the Air Force to be enthusiastic over. The reason is that the Pentagon budget process is such that new programs are seldom recognized as complementary to, but rather as substitutes for."[63] Under TAC there was no serious follow-on study of UAVs to determine potential capabilities, roles in war, place in the force structure, nor

concept of operations.[64] A 1974 Air University study, however, described conceptual programs capable of developing and fielding strike RPVs by the 1980s.[65] A 1975 industry study also revealed the heightened focus on RPVs during this time frame: "A great deal has been written in both the general and trade press over the past two years about drones and RPVs with much of the space devoted to the more exotic applications of unmanned vehicles such as aerial combat with manned aircraft."[66] The actual result is that only five years after proving their use in Southeast Asia, the United States would not have a single operational RPV in its inventory.

Lack of user support also restricted development of UAVs more than technological hurdles.[67] Speaking at an RPV symposium in June 1977, Lt Gen James D. Hughes, Twelfth Air Force commander, expressed operator discontent with the evolution of RPVs. "Most of the problems encountered in the AQM-34V Program," he stated, "are because the drone is antiquated; the launch platform is antiquated; control technicians are antiquated; and the recovery of the vehicle is far too complex--and once recovered, the turnaround takes too long."[68]

In 1981 a General Accounting Office (GAO) study stated, "RPVs appear to suffer from the attitude of the users and not from technological drawbacks or infeasible systems.[69] It also reiterated that UAVs were not popular with the military due to user reluctance and lack of funding support.[70] While it is difficult to justify reluctance for past users, it is nearly impossible to do so for present users. Many sources assert or mention user reluctance as a barrier to UAV development, but they offer little evidence. Since the time of Hap Arnold, there has yet to appear a US military leader who has even come close to displaying his level of interest and support for unmanned aircraft. While this may not prove reluctance, it does indicate indifference exists in decision-making ranks to support this form of airpower.

In 1989 the UAV Joint Project Office was officially established in response to congressional direction. In 1988 (with subsequent updates) the Department of Defense (DoD) developed the "Unmanned Aerial Vehicle Master Plan." In spite of these efforts to establish oversight of UAV development in the United States, the GAO severely criticized DoD's plan.[71]

POST COLD WAR

Despite doctrinal statements that it "should be in the forefront of developing and exploiting aerospace power,"[72] the USAF did not aggressively pursue UAV development. Similar to the way the Army developed armed helicopters (for close air support) in the face of the 1948 Key West Agreement, the Army, Navy, and Marine Corps each pursued UAVs to support their service-unique, "organic" reconnaissance requirements. During Operation DESERT STORM, 43 Pioneer UAVs flew 330 sorties among the three services with only one

loss. These assets provided intelligence, targeting information, artillery spotting, and battlefield damage assessment. One Pioneer aircraft on an artillery support mission actually imaged Iraqi troops trying to surrender to it.[73] In contrast, the Air Force relied on RF-4 aircraft for its tactical reconnaissance missions. These manned assets required "SAM suppression, electronic countermeasures, aerial refueling, Airborne Warning and Control System (AWACS), and Airborne Battlefield Command and Control Center (ABCCC) support."[74]

In July 1995, the USAF stood up its first UAV squadron at Nellis Air Force Base (AFB), Nevada. The first of its kind since Vietnam, the squadron received its Predator UAVs in 1996. The Air Force chief of staff at the time said the Air Force has "embraced" the UAV. While this statement indicated UAVs were gaining acceptance, approval was primarily limited to reconnaissance roles until the September 11, 2001 attacks. In March 2002, the USAF stood up its first armed UAV squadron at Indian Springs Auxiliary Airfield, Nevada. The Air Force chief of staff at this time asserted that prior to the terrorist attacks, he had difficulty in getting service officials to develop an attack capability on Predator UAVs. "People blanched out and fainted" about this proposal, General John Jumper said.[75]

In December 2002, the Department of Defense (DoD) published *Unmanned Aerial Vehicles Roadmap* to provide a vision for developing and employing UAVs and Unmanned Combat Air Vehicles (UCAVs) over the next 25 years. DoD projected that it will invest over $10 billion by 2010 for future UAV development, procurement, and operations. Future capabilities include "F-16-size UAVs capable of supporting a variety of combat and combat support missions" and "vertical takeoff UAVs (rotary wing) capable of extremely long endurance (18-24 hours)." This is compared to $4 billion invested over the previous 12 years. While the roadmap is to "usher in a new era of capabilities and options for our military and civilian leaders,"[76] the promotion of UAVs to have a prominent role in military transformation is not new.

Nearly a decade ago, then Secretary of the Air Force (SECAF), Dr. Sheila Widnall, released a study titled *New World Vistas*. The paper projected advances of air and space concepts into the future. Prominent among the report's futuristic initiatives were concepts of uninhabited fighter aircraft capable of flying 10 to 15 times the speed of sound, maneuvering at 20 times the force of gravity, and using high-powered lasers to destroy air and land targets. Despite the former SECAF's assertion that "this study is not going to sit on the shelf and gather dust,"[77] the trend of UAV development since that time indicates it is difficult to implement these sorts of futuristic initiatives.

Another decade may pass, only to result in an updated repackaging of the *New World Vistas* or the *Unmanned Aerial Vehicles Roadmap*. Unless the UAV identity crisis is understood

and overcome by strategic leaders, actual support for truly innovative UAV roles and missions will not be fully realized and advanced UAV development will remain stagnated.

CONCLUSION

> Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur. In this period of rapid transition from one form to another, those who daringly take to the new road first will enjoy the incalculable advantages of the new means of war over the old.
>
> —Giulio Duhet, *The Command of the Air*

Military theorists, such as airpower theorist Giulio Duhet, recognized the revolutionary nature of new technology that would forever change warfare. Early airpower theorists expressed their visions of airpower through descriptions of its inherent qualities and prescriptions of propositions for its employment. Much of what they articulated is invaluable and timeless in nature. Unfortunately, many other airpower predictions proved incorrect. Many promises remain unfulfilled throughout tests of war and conflict over time.

Today we better understand airpower's strengths and weaknesses. Using doctrinal underpinnings, lessons of war, and technological advances as guidelines, the quest continues to further comprehend and exploit the numerous advantages of airpower. In examining unmanned airpower, the UAV's sense of identity is ambiguous today due to past adversities. Negative influences upon UAV development span across a historical timeline filled with biases (e.g., leadership bias, user bias, institutional bias, etc.) and budgetary setbacks.

By tracing and examining historical roots it is evident the United States had no organized plan nor structure which purposely led unmanned aircraft to its current state of existence. Historical circumstances, however, did have an unfavorable effect upon any significant advancement of UAV roles and missions. During major modern wars and conflicts, UAV development revealed promising capabilities into a new realm of airpower. Technological hurdles were encountered, but these were often overcome with new and innovative discoveries. However, when the wars ended and military budgets had to be cut, UAV research and development projects were always among the first to be sacrificed. UAV platforms were never able to mature enough to secure strong support structures in cultural, scientific, military, nor political arenas.

Lack of UAV development was not due to lack of strategic vision. Unlike other airpower

means (and space-based systems), UAVs were not initially developed to serve as reconnaissance platforms in war. The first UAVs were envisioned, researched, and developed to be weapons of destruction. Lorin's first UAV concept was of a flying bomb to strike distant targets. The first drones and RPVs were flying bombs. Professor Low worked on developing unmanned airplanes for interceptor and ground attack roles. Sperry and Kettering developed aerial torpedoes. Subsequent developments for RPVs focused on providing aerial targets for antiaircraft gunners to test their skills. The first operational use of UAVs in war—by Germany as well as by the United States—was for strategic attack. While the potential for more diverse roles clearly existed, the United States would eventually focus and fixate on reconnaissance applications.

"Changes in the military's strategic thinking have come only in the wake of full-blown disaster."[78] The shootdown of Powers clearly was the key event that made reconnaissance the primary driver for US development and operational use of unmanned aircraft since 1960. Proven effective in Southeast Asia, it appeared the UAV had secured at least intelligence gathering, decoy, and chaff/leaflet dispensing roles for high-risk missions. After the Vietnam conflict, responsibility passed from SAC to TAC, and subsequent USAF interest waned. Over the past three decades, the Air Force displayed a largely indifferent attitude towards exploration and exploitation of UAVs beyond reconnaissance roles.

The terrorist attacks of September 11, 2001 changed the military's strategic thinking to catalyze development of an armed Predator and accelerated the fielding of Global Hawk. While there are new roadmaps and new conferences to discuss next-generation UAVs, past trends indicate very little UAV development beyond Predators and Global Hawks will be realized in the next decade. Current and future decision-makers must move beyond published writings, symposia, speeches, and discussion on UAVs—hopefully, they will lead to truly determine, realize, and exploit the full spectrum of strengths, as well as weaknesses, of unmanned aircraft.

Strategic visionaries must have open minds to explore new ways of developing, transforming, and employing assets. They must search for new approaches in order to best support effective application of all instruments of power. The United States of America can no longer simply respond to the changing environment with belated modifications to existing systems and strategies. In order to remain the world's greatest superpower, US strategic leaders must be openly aggressive in the pursuit of innovation. The UAV's identity crisis has not prevented the world's greatest airpower force from gaining and maintaining its present state of superiority. It has, however, prevented the United States from appreciating and harnessing the full potential of UAVs. This may prove to be of great consequence in a future of ambiguous

threats and challenges, as well as potential technological advancements, never before envisioned just a few years ago.

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ENDNOTES

[1] Carl H. Builder, *The Masks of War* (Baltimore: John Hopkins University Press, 1989), 185.

[2] Air Chief Marshal Sir Michael Armitage, *Unmanned Aircraft* (London: Brassey's Defence Publishers, 1988), 34.

[3] Ibid., 35.

[4] I. B. Holley Jr., "Of Saber Charges, Escort Fighters and Spacecraft: The Search for Doctrine," *Air University Review*, September-October 1983), 2.

[5] Jay Luvaas, *The Education of an Army: British Military Thought, 1815-1940* (Chicago: University of Chicago Press, 1964), 355.

[6] Lee B. Kennett, *The First Air War, 1914-1918* (New York:: Free Press, 1991), 27.

[7] Ibid.

[8] B.H. Liddell Hart, *Foch: The Man of Orleans* (London: Eyre and Spottiswoode, 1931), 47. Of significance is that General Foch, who later became supreme commander of Allied forces in France, was an astute observer of warfare and authored *Principles*, which was used at the war colleges.

[9] The US Air Force changed the designation from RQ-1 to MQ-1 to represent the multi-mission capability of the armed reconnaissance Predator.

[10] "The RPV/Drones/Targets Market, 1975-1985," marketing study (Greenwich, Conn.: DMS, Inc., 1975). One could argue that the first pioneers in aviation were also the first to develop UAVs via their earliest experiments. "First flights of the Montgolfiers' balloon were unmanned as were those of the Wright brothers' Flyer."

[11] Armitage, 1. Lorin proposed using gyroscopes, barometers, jet engines, and guiding radio signals from an accompanying piloted aircraft in his weapon design.

[12] Ibid.

[13] John W. R. Taylor and Kenneth Munson, eds., *Jane's Pocket Book of Remotely Piloted Vehicles: Robot Aircraft Today* (New York: Macmillan, 1977), 11. It was suggested that Professor Low is the "Father of the Remotely Piloted Vehicle." Others bestow Kettering with this title.

[14] Steven M. Shaker and Alan R. Wise, *War Without Men: Robots on the Future Battlefield* (Washington, D.C.: Pergamon-Brassey's, 1988), 21.

[15] Ibid.

[16] Shaker and Wise, 24.

[17] Jay Womack and Arthur Steczkowski, "Review of Past and Current Trials and Uses of Unmanned Vehicles," Report no. HSD-TR-87-011/Unided States (Air Force Systems Command,

1988), 2-1; James E. Biltz et al., "The RPV: Yesterday, Today, and Tomorrow" (Maxwell Air Force Base, Ala.: Air University, 1974), 13-16; Shaker and Wise, 22; and Armitage, 3. The Kettering Bug's official name was the Liberty Eagle. The Army Air Corps initially ordered 75 copies, but only 20 were produced due to World War I coming to an end.

[18] Womack and Steczkowski, 2-2.

[19] Shaker and Wise, 24.

[20] Armitage, 6; and Shaker and Wise, 25.

[21] Ibid.

[22] Womack and Steczkowski, 2-4.

[23] Shaker and Wise, 26.

[24] Womack and Steczkowski, 2-3.

[25] Armitage, 7.

[26] Ibid., 16-17.

[27] Ibid., 16.

[28] Ibid., 17.

[29] Shaker and Wise, 28.

[30] Michael J. Neufeld, *The Rocket and the Reich: Peenemunde and the Coming of the Ballistic Missile Era* (New York: Free Press, 1995), 274.

[31] Armitage, 19.

[32] Ibid., 19-24.

[33] Within three weeks in mid-1944, engineers at Wright-Patterson Field, Ohio, duplicated the V-1 design by examining thousands of pounds of salvaged German V-1 parts. The American version was designated the JB-2 and nicknamed "Wendover Willie" for the Army Air Force and "Loon" for the Navy variant. 1,385 JB-2s were produced and delivered to the US War Department, but the project was terminated with the end of the war.

[34] Ibid., 22-24.

[35] Biltz et al., 22-24; Shaker and Wise, 26; Armitage, 30-32; and Conrad C. Crane, *Bombs, Cities, and Civilians: American Airpower Strategy in World War II* (Lawrence, Kans.: University Press of Kansas, 1993), 78-89. Crane's book provides good background on Project Aphrodite.

[36] Crane, 80. As noted earlier 2,900 men and 450 aircraft had been lost.

[37] Ibid.

[38] Ibid., 80-82. Contains quoted material on these three war-weary missions.

[39] Ibid., 78.

[40] Armitage, 27-30.

[41] Shaker and Wise, 30. Introduced were three conceptual aircraft named Glomb, Gorgan, and Gargoyle, and they were described by the Navy to be “robot craft.”

[42] Biltz et al., 25; and Armitage, 30. In one attack, two bridge spans were taken out with one glide bomb. It is noted that these bombs did eventually become more effective with improvements in materials and crew training. One major drawback was the inability to safely jettison them from damaged aircraft.

[43] The Firebee was capable of carrying a wide variety of weapon systems including infrared or television-guided bombs and missiles. It had a maximum speed near Mach 1, had a range of 1,415 miles, and could reach altitudes of more than 60,000 feet. The Firebee II had a maximum speed of Mach 1.8 and could sustain 5-G turns. Both Firebee models can be seen at the Air Force Armaments Museum (AFAM) at Eglin AFB, Florida.

[44] Armitage, 65-86.

[45] Taylor and Munson, 28.

[46] Two months later, the Soviets shot down an American RB-47 electronic intelligence collector over the Barents Sea; five crewmen were killed or missing and two were captured. The United States subsequently suffered an 18-month gap in its reconnaissance capabilities, from the U-2 downing until the first US surveillance satellite could be launched.

[47] L. Fletcher Prouty, letter to *Air Force Magazine*, April 1996, 5-6. This is usually referred to as the “U-2 shootdown”; however, there is evidence that the aircraft was not actually shot down.

[48] Armitage, 66; and Dana A. Longino, *Role of Unmanned Aerial Vehicles in Future Armed Conflict* (Maxwell AFB, Ala.: Air University Press, 1994), 2. Longino provides a discussion on the decision to turn off the reconnaissance RPV program in light of developing satellite systems and the SR-71.

[49] Armitage, 68.

[50] Ibid., 71; and Shaker and Wise, 31. This was the public’s first view into the world of RPVs performing roles deemed too dangerous or too politically sensitive to be performed by human pilots. New versions of drones reached altitudes higher than what the Chinese SA-2 missiles could intercept. These flights continued until the establishment of improved US-China relations, and overflights were suspended in 1973.

[51] Armitage, 75-76.

[52] Longino, 3.

[53] Ibid., 3-5.

[54] Armitage, 74. This version carried an electronic countermeasures package along with its photographic reconnaissance equipment.

[55] Kenneth Munson, *World Unmanned Aircraft* (London: Jane's Publishing Company Ltd., 1988), 7. This drone was appropriately named "Top Cat."

[56] Ibid.

[57] William E. Krebs, "Did We Err in the Development of Remotely Piloted Vehicles (RPVs)?" Research Report no. MS 018-79 (Maxwell AFB, Ala.: Air War College, 1979), 50.

[58] Ibid., 15.

[59] Taylor and Munson, 30-33.

[60] Matthew M. Hurley, "The Bekaa Valley Air Battle, June 1982: Lessons Learned?" *Airpower Journal*, Winter 1989, 60-70. While many sources detail Israeli use of UAVs during the Middle East conflicts, a unique perspective on their applications is provided by Hurley.

[61] General Accounting Office, *DOD's Use of Remotely Piloted Vehicle Technology Offers Opportunities for Saving Lives and Dollars* (Washington, D.C.: U.S. General Accounting Office, 3 April 1981), 8.

[62] Anne Marie Cunningham, "Unmanned Flying Vehicles," *Technology Review*, April 1991, 16.

[63] Krebs, 47.

[64] Krebs, 48. General Sylvester made these arguments at a 1978 RPV symposium.

[65] Biltz et al., 56-63.

[66] "The RPV/Drones/Targets Market, 1975-1985."

[67] Ronald L. McGonigle, "Unmanned Aerial Vehicles (UAVs) on the Future Tactical Battlefield—Are UAVs and Essential Joint Force Multiplier?" (Fort Leavenworth, Kans.: 8 December 1992). This argument has been made in various forms. For example, a related assertion is that overcoming organizational resistance, not technology, is the major barrier to RPV acceptance.

[68] Krebs, 27.

[69] GAO study, 8.

[70] Ibid., 10.

[71] General Accounting Office, *Unmanned Vehicles: Assessment of DoD's Unmanned Aerial Vehicle Master Plan* (Washington, D.C.: U.S. General Accounting Office, December 1988).

[72] Department of the Air Force, *Basic Aerospace Doctrine of the United States Air Force,* Air Force Manual 1-1, vol. 1, (Washington, D.C.: U.S. Department of the Air Force, March 1992), 17.

[73] Richard P. Hallion, *Storm Over Iraq: Air Power and the Gulf War* (Washington, D.C.: Smithsonian Institution Press, 1992), 312.

[74] Longino, 9-13. The author provides a good account of UAV and RF-4 operations in Desert Storm.

[75] Marc Strass, "Air Force Stands Up First Armed Predator UAV Squadron," 11 March 2002; available from <http://www.freerepublic.com/focus/fr/644350/posts>; Internet; accessed 6 March 2004.

[76] Under Secretary of Defense (AT&L) E.C. Aldridge, Jr. and Assistant Secretary of Defense (C3I) John P. Stenbit, "Unmanned Aerial Vehicles (UAV) Roadmap," memorandum for Secretaries of the Military Departments, Washington, D.C., 11 March 2003.

[77] Gary Pomeroy, Air Force News Service, "New World Vistas' Study Focuses on AF's Future," *Maxwell-Gunter Dispatch*, 9 February 1996: 16.

[78] Builder, back cover.

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